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BULLETIN OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

Vol. V LANCASTER, PA., MAY, 1915 No. 9

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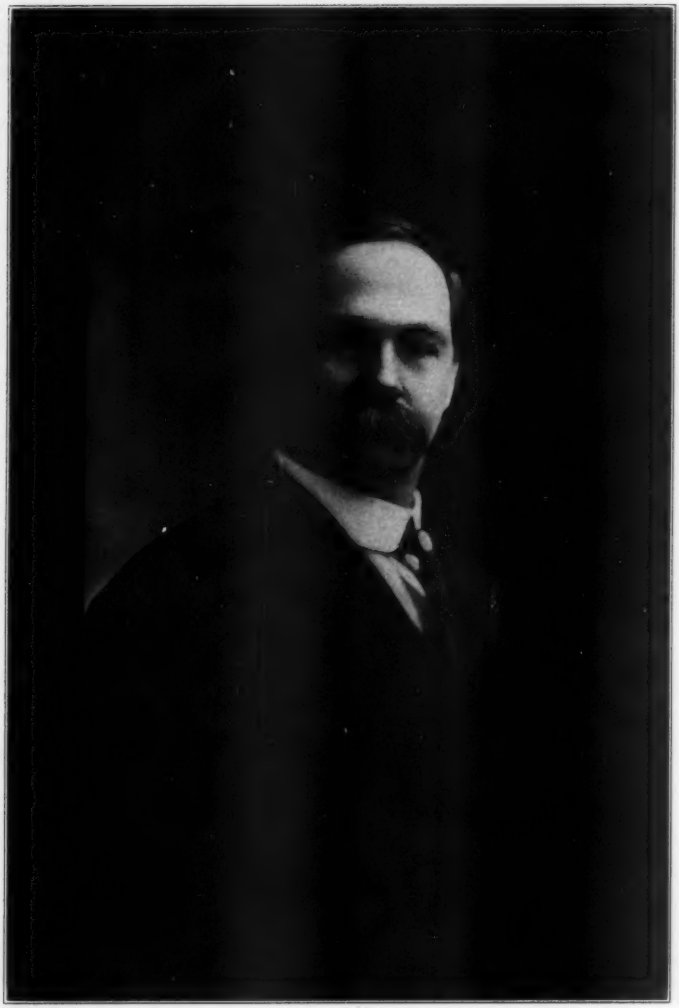

ANSON MARSTON,

President Society for the Promotion of Engineering Education, 1914–15.

See page 3.

BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

ANSON MARSTON, H. H. NORRIS, F. L. BISHOP, *Editor*.

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. V LANCASTER, PA., MAY, 1915 NO. 9

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EDITORIALS.

Opportunities in Teaching.—That there are opportunities in teaching equal to, or perhaps superior to those offered in commercial life, is evidenced by the fact that the Secretary has recently been visited by the dean of the school of engineering of a large university, who is trying to fill three positions, each of which pays $5000 per year, with opportunities to do more or or less consulting work. While this is not a large salary in comparison with some obtained in commercial life, it is true that a teaching position carries privileges and opportunities for service not found in any other walk of life. The satisfaction which comes to a teacher from work well done is greater than that from any other source.

The time has come when every endeavor should be made to interest the best men of our graduating classes in the truly great profession of teaching.

LETTERS TO THE EDITOR.

THROOP COLLEGE OF TECHNOLOGY

PASADENA, CALIFORNIA

PRESIDENT'S ROOM April 27, 1915

My dear Mr. Bishop:

I have your letter of April 20.

While regretting that we are not yet prepared to send our delegate to the annual meeting of the Society for the Promotion of Engineering Education, I take pleasure in saying that it is my intention to include a request for an appropriation for this purpose in the budget just about to be considered. After this year it is my hope that Throop may be represented at every annual meeting of the Society.

Thanking you for your kind invitation, and congratulating you upon the success of the Society, I remain

Sincerely yours,

JAMES A. B. SCHERER.

Mr. F. L. Bishop,
The University of Pittsburgh,
Pittsburgh, Pennsylvania.

PERSONALS.

PRESIDENT ANSON MARSTON,

DEAN OF ENGINEERING, DIRECTOR, ENGINEERING EXPERIMENT STATION, IOWA STATE COLLEGE.

Anson Marston was born at Seward, Illinois, May 31, 1864. He was brought up on an Illinois farm, was educated in the public schools of Winnebago County, and graduated from the West Rockford (Illinois) high school in 1883. He then taught country school to earn money to go to college. He attended Berea College in 1844–45 and entered the civil engineering course at Cornell University in 1885, receiving the C.E. degree in 1889. At the beginning of his Freshman year he won the Cornell scholarship in a mathematical competition.

All of his summer vacations were spent at railroad location and construction work on a branch of the Illinois Central Railroad, of which Mr. Isham Randolph was chief engineer. Immediately after graduation he was resident engineer on railway construction at St. Joseph, Mich., and in November of the same year went south for the Missouri Pacific Railroad, on location and construction work in Arkansas and Louisiana. He remained there two and one half years, during which time he held the positions of transitman, resident engineer, and chief of locating party. During the last year and a half he had charge, as resident engineer, of the construction of the Ouachita River Draw Bridge.

On March 1, 1892, he went to the Iowa State College as

professor of civil engineering, which position he still holds. In 1898 he was made college engineer and in that position had charge of the construction of practically all the buildings erected since that time. He made the detailed designs for the college water tower, constructed in 1898, and for the college sewage disposal plant constructed in the same year. The disposal plant was the first to be built in the State of Iowa.

In 1904 he was made dean of the engineering division, and director of the engineering experiment station, and was from 1904 until 1913 associated with the dean of the division of agriculture as director of the state highway commission.

In addition to his college work, Dean Marston has done some outside engineering work, including the designing or general direction of construction of sewerage systems or sewage disposal plants; the designing and construction of water works systems; special reports on sewerage systems and water supply plants; valuation of water works systems; consulting engineering work on large municipal reinforced concrete bridges.

Dean Marston is a member of the American Society of Civil Engineers, the Western Society of Engineers, the American Society for Testing Materials, the Society for the Promotion of Engineering Education, the Land Grant College Engineering Association, the Iowa Engineering Society, the Iowa Academy of Science, and other state and national societies of technical or scientific nature. In many of these he has been very active in a directory way, in many instances holding the presidency as well as other offices. He is also a member of the honorary fraternities Sigma XI, Tau Beta Pi and Phi Kappa Phi. He is a Mason, and a member of the Sons of the American Revolution.

Professor Vladimir Karapetoff, of the Electrical Engineering Department at Cornell University, has been appointed by President Moore to act on the International Jury of Awards, in the electrical division, at the Panama Pacific Exposition. He expects to leave for San Francisco on Tuesday, April 27, and will return about the middle of June.

SOCIETY NOTES.

President Marston paid the Secretary a brief visit Friday, April 23, to discuss final plans for the Ames meeting.

There is on file in the office of the Secretary the academic records of a number of teachers who would like to make a change. The Secretary would be glad to send a copy of these to any institution needing men.

You may expect your June BULLETIN not later than June 10.

A copy of the preliminary program for the Ames meeting was mailed April 29 to each member. A return card was enclosed. If you have not already done so, please mail this card at once.

Men of Science and Industry.—At the Niagara meeting of this Society at the suggestion of Mr. Waddell, a committee was appointed on the "History and Biography of the Engineering Profession." The Committee consisting of Messrs. Williston, Merriman and Raymond presented a report at the Atlantic City meeting. The Committee reported that the task of gathering together the necessary material and editing it was greater than the Society could undertake. This work has been taken up by the Carnegie Library of Pittsburgh and its results published in book form.*

The character of this book is shown by the following abstract from the preface:

"The desirability of introducing the young scientist to the personality of his predecessors has long been recognized by those interested in education. The student will find that the best way into any science is through history of the discoveries that have made it a science. By following the footsteps of

*"Men of Science and Industry," a guide to the Biographies of Scientists, Engineers, Inventors and Physicians in the Carnegie Library of Pittsburgh. Copies of this book can be obtained from the Library postpaid for $.30.

those who have found their way to the truth, we pursue natural, if seemingly vagrant, paths. The difficulties of discovery that the pioneers of the science met are the difficulties that the student encounters. Moreover, there is a human interest about the struggles of a man with the problems of the world that adds much to the hard facts of a science, and gives one of the needed graces to the stern features of any physical inquiry." (*Shaler and Davis, Illustrations of the Earth's Surface.*)

"Although the material relating to the lives of scientists and engineers is considerable in quantity, it is widely scattered and difficult of access. This condition was recognized many years ago by the Society for the Promotion of Engineering Education, which appointed a committee of investigation, but as yet no feasible plan for a uniform editing of the material has been found. In the meantime, this Library has compiled a card index to the biographies in its own collection, and this bibliography is now printed in the hope that it may prove useful to others, even though it is confined to the resources of one library.

"The list is, in general, limited to men whose work is concerned with the subjects represented in the classes Science and Useful Arts, of the Decimal Classification. On this basis some men prominent in business, engineering and invention are included whose rank as scientific workers may be questioned. The limitation to one collection, and that not one attempting completeness, will account for the absence of certain names which might reasonably be expected to appear. The brief characterizations attached to the names have sometimes given difficulty because of the varied aspects of some men's work, but the endeavor has been to choose the field in which each has made his most important contributions to science. A man's birthplace has been considered as determining his nationality.

"The original intention was to include only books about individuals and collections of biographies, omitting references

to the periodical press. This plan was modified by the inclusion of references to the publications of some societies which print obituary notices of members and a few scientific and technical journals which contain numerous biographical sketches. No reference to general periodicals are given except a few from Poole's Index to additional material on men already in the list. The names of those who appear in the Dictionary of National Biography are indicated by asterisks.

"A list of books systematically indexed is given below, also a list of biographical dictionaries and some other works useful for reference in this connection. Among the latter may be especially mentioned the Indexes to the Proceedings of the Institution of Civil Engineers, which contain references to some 2500 names.

"The plan, compilation and annotation of this list are the work of Miss Marion Knight and Mr. E. H. McClelland."

APPLICANTS FOR MEMBERSHIP.

BRAY, G. E., Industrial Engineer, Kansas State Agricultural College, Manhattan, Kans.

GEARHART, W. S., State Engineer and Professor of Highway Engineering, Kansas State Agricultural College, Manhattan, Kans.

HAY, E. D., Professor of Drawing and Machine Design, Oshkosh Normal School, Oshkosh, Wis.

NEW MEMBERS.

ARNETT, L. D., Librarian, West Virginia University Library, Morgantown, W. Va.

BARBA, C. E., Assistant Engineer in Office of M. E., Pennsylvania Railroad, Altoona, Pa.

CRAWSHAW, F. D., Professor of Manual Arts, University of Wisconsin, Madison, Wis.

DOUGHERTY, H. R., Professor and Head, Dept. Mathematics, New York Military Academy, Cornwall-on-Hudson, N. Y.

DRAGOUN, F. A., Instructor in Civil Engineering, Iowa State College, Ames, Ia.

GALPIN, S. L., Assistant Professor of Geology and Mining, Iowa State College, Ames, Ia.
KIRKHAM, J. E., Professor of Structural Engineering, Iowa State College, Ames, Ia.
PORTER, R. L., Head of the Dept. Mechanical Engineering, Iowa State College, Ames, Ia.
ROCKWELL, R. L., Head of the Dept. Electrical Engineering, Seattle Engineering School Inc., Seattle, Wash.
KANSAS STATE AGRICULTURAL COLLEGE, H. J. Waters, President, Manhattan, Kans.

BOOKS RECEIVED.

Engineering Economics. By JOHN C. L. FISH. Published by McGraw-Hill Book Co.

Analytic Geometry of Three Dimensions. By GEORGE SALMON. Published by Longmans Green and Company, New York. 1915.

BOOK REVIEWS.

Foundations. By MALVERD A. HOWE, C.E., Professor of Civil Engineering, Rose Polytechnic Institute. Cloth, $1.25 net. Jno. Wiley and Sons, New York. 1914.

The author presents only general conditions and methods of design. Illustrations are taken from actual constructions but the description is omitted. A large list of references to the subject under consideration closes each chapter.

J. S. L.

Working Data for Irrigation Engineers. By E. A. MORITZ, B.S.C.E., C.E., Assoc. M. Amer. Soc. C.E., Engineer United States Reclamation Service. John Wiley & Sons, Inc., New York. 1915. Pp. 395. Price, $4.00 net.

This book, as the author states, is an attempt to supply a "handbook" or "pocketbook" especially adapted to the needs of the engineer specializing in irrigation work. In preparing it, the author has had the advantage of having at his disposal the records of the United States Reclamation Service. He is

able, therefore, to make available to the rest of the profession much of the valuable data accumulated by that organization in connection with its extensive irrigation work, as when he includes the results of experiments and measurements on duty of water, seepage from canals, values for canals and ditches of the coefficient in Kuttner's formula, etc. The book comprises three chapters on reconnoissance, investigation and design of irrigation projects; two chapters of hydraulic and structural diagrams and tables, in which graphic presentation on logarithmic paper is freely and effectively used; a chapter of miscellaneous tables and general engineering data; and a useful chapter including the general specifications and sample detail specifications used by the Reclamation Service in contracts. It would add to the value of the book for reference, if it were published in the conventional "handbook" form which the engineer has found so useful in the field and in the draughting room.

M. R. S.

Masonry. By MALVERD A. HOWE, C.E., Professor of Civil Engineering, Rose Polytechnic Institute. 260 pp., 6 x 9. Cloth, & — net. John Wiley and Sons, New York.

A short text-book on masonry construction including descriptions of the materials used; their qualities, preparation and arrangement in structures. Modern methods and tools are described and illustrated. Plain concrete construction is included. The last chapter is devoted to a classification of, and specifications for, various building materials.

J. S. L.

COLLEGE NOTES.

Lafayette College Notes.—Mr. W. O. Hay, General Manager of the Northampton Traction Company, has presented the Department of Electrical Engineering a set of the Proceedings of the American Electric Railway Association covering a number of years.

Messrs. J. H. Kerrick, P. M. Lee and J. H. Kennedy, members of the Senior class in the Department of Electrical Engineering, are making a study of the power requirements and consumption of the various electric railway lines in and about Easton, Phillipsburg and Bethlehem, including the Liberty Bell line to Philadelphia. Some of the interesting tests have been made on the new type swiveling single truck which is being tried out under one of the Easton cars. The various electric railways are cooperating with the Department of Electrical Engineering in this work and the tests bid fair to be of great value to the companies. The experimental work alone will require a number of weeks.

The Lafayette Branch of the American Institute of Electrical Engineers has elected as its officers for the coming year L. Rodman Fox, of Easton, president, and Frank H. Schlough, of Easton, secretary.

Professor James T. Rood, of the Department of Electrical Engineering at Lafayette College, has been elected a Fellow of the American Association for the Advancement of Science.

Massachusetts Institute of Technology.—The department of Mining Engineering and Metallurgy of the Massachusetts Institute of Technology has received through the courtesy of Col. Charles Hayden, '90, a member of the corporation, an interesting addition to its laboratory equipment. This is a complete working unit of the Janney oil flotation apparatus, the machine being fitted with more than the usual adjustments for producing and meeting various conditions. It has an electrical control to enable it to be worked at different speeds and observation windows for noting the interior happenings.

The process of oil flotation is a comparatively new one in the development of ore dressing and is making great advances. The process is in part chemical and in part mechanical, due in the first place to the affinity which oils have for certain kinds of minerals, the sulphides, while they have no action upon the containing rock. In submitting the ground crude ore to the oil, the latter coats the sulphide particles with a film

of oil, while the gangue or enclosing rock is unaffected. A second process consists in charging mixture with air, which attaching itself to the oily particles makes for them a sort of life raft and floats them away to separation from the useless rock.

Mill men throughout the country are experimenting with the oil flotation process and in many cases have installed outfits in their mills. The increased profit accruing to operators through the process is already estimated as in the millions while in fact the development of it can hardly as yet be said to have begun.

The title of Professor A. E. Kennelly has been changed from chairman to director of the Research Division of the department of Electrical Engineering.

University of Illinois.—The following lectures have been delivered before the faculty and students of the College of Enginering: Prof. W. K. Hatt, of Purdue University, on "Flood Prevention in Indiana," and Prof. G. A. Goodenough, of the Department of Mechanical Engineering, on "The Development of the Steam Turbine." Prof. L. H. Provine, of the Department of Architecture, gave a lecture on the "Crookedest Railway in the World" at Purdue University recently. Prof. I. O. Baker, of the Department of Civil Engineering, gave a lecture on "Selecting the Road Surface" at the University of Michigan recently.

Methods and apparatus have been developed by the Department of Physics of the University of Illinois, whereby the reflection, absorption, and transmission of sound for different materials may be tested experimentally. A large basement room in the Physics Laboratory, with cemented walls, ceiling, and floor, serves as a resonance chamber for the absorption tests, while a specially constructed resonator and organ pipe are used to measure the reflection and the transmission. The work has been developed by Dr. F. R. Watson, under whose direction the correction of the acoustic properties of the University Auditorium was so successfully carried out. This

equipment is to be used in connection with a proposed course in instruction in architectural acoustics.

The Engineering Experiment Station is conducting tests of various building materials to determine their coefficients of heat transmission. The work is being done by Mr. L. C. Lichty, Research Fellow, under the direction of Professor L. A. Harding, of the Department of Mechanical Engineering. The results of the tests are expected to be of especial value to heating and ventilating engineers.

During the past year the Department of Mechanical Engineering has been developing work along the lines of heating and ventilation under the direction of Professor A. C. Willard. A considerable amount of equipment for the experimental study of heating and ventilating problems has been installed within the last few months.

An interesting experimental unit consisting of a 60-h.p. automobile engine direct connected to a hydraulic resistance dynamometer has been installed in the Mechanical Engineering Laboratory. The dynamometer is a local product, being designed by C. R. Richards, Professor of Mechanical Engineering, and built in the shop laboratories.

Of lectures recently delivered before the College of Engineering, were several of unusual interest among which are "Engineering Work in China," by Daniel W. Mead of the University of Wisconsin; "The Economic Significance of the Fire Waste," by Franklin H. Wentworth, Secretary of the National Fire Protection Association; "The Engineering and Economic Results of Reclamation Work," by Frederick H. Newell, former director of the Reclamation Service.

The regular biennial Electrical Show was held from April 8 to 10 in the Electrical Engineering Building and Armory. The "Show" is an exhibit of electrical apparatus, machinery, and equipment staged alternate years by the students in electrical engineering for the purpose of giving the general public the opportunity of viewing the latest developments in elec-

tricity and electrical devices. Attendance was large this year and the show was a success in every way.

University of Minnesota.—Most of the members of the faculty of the College of Engineering are members of the Society for the Promotion of Engineering, and plans are in the making for a motor trip between Minneapolis and the Iowa city where the meeting is to be held. Those who have already signified their intention of driving their cars on this journey are Professors Kavanaugh, Martenis, Rowley, Ryan, Shipley and Dean Shenehon.

The distance between the two cities is too great for a comfortable one-day run so that a stop over at Mason City is probable.

Mr. H. S. Loeffler and Mr. M. B. Lagaard, post seniors, students in the College of Engineering of the University of Minnesota and for the past year and one-half Research Assistants in the Department of Experimental Engineering, have been given a leave of absence from the College for two weeks to assist in the tests of some steel bridges and viaducts in Montana for the Northern Pacific R. R. These tests are being conducted by the Bridge Dept. of the R. R. Co. under Mr. H. E. Stevens, bridge engineer, with instruments loaned by the American R. R. Engineering Association.

University of Washington.—The annual short session for mining men at the University of Washington closed its eighteenth year on April 2. In many respects the session was the most successful in years. Thirty-eight students registered for the work, two of whom were women. Of the entire registration thirty remained for practically the entire period. Quartz mining subjects appealed to the greater number, with placer mining next in interest. The oldest student was 52 years old, the youngest 19. Eleven of the men had previously attended some college and three were graduates. Most of the remaining students came with ordinary school preparation. Washington, British Columbia and Alaska were given as the addresses for most of those attending. Three students had previously

attended the short session and returned for special work. Next year the nineteenth session will begin on January 3 and run for three months.

Following the close of the short session the junior and senior classes of the College of Mines together with a few of the short course men, visited the Index and Blewett mining districts of the state. Nineteen men made up the party. Several days were spent at Index studying the Sunset, the Copper Bell and the granite quarries of this section. At Blewett, which is the oldest mining camp in the state, gold mining and milling and the geology of the district were investigated.

OBITUARY.

FREDERICK WINSLOW TAYLOR.*
1856–1915.

Frederick Winslow Taylor, noted as the founder of the science of management, died suddenly of pneumonia on March 21, 1915. He was born in Germantown, Pa., in 1856. His eyesight became impaired in young manhood, necessitating his giving up his educational plans, and he became an apprentice with William Sellers & Company. After learning the trades of patternmaker and machinist he entered the employ of the Midvale Steel Company and from a humble beginning in 1878 became chief engineer in 1884. While here he studied at night and received the degree M.E. in 1883 from the Stevens Institute of Technology.

At Midvale Mr. Taylor began the systematic study of problems relating to the output of tools and men which later became his life work. Between 1890 and 1893 he was manager of The Manufacturing Investment Company, operating large

* This sketch was based upon an appreciative article appearing in the *A. S. M. E. Journal*, April, 1915, page 9.

paper mills in Maine, and left this company to take up consulting practice. As part of this work he accomplished remarkable results for the Bethlehem Steel Company, inventing, with Maunsel White, a process of heat treatment which permitted the manufacture of high-speed tool steel. At the same time he caught a vision of the possibilities of scientific management in all branches of industrial development.

He had by this time acquired a competence and for the balance of his life he devoted his energy and experience to the cause of industrial progress without compensation. He served as vice-president and as president of the American Society of Mechanical Engineers, to which he gave much of his best thought. He was of recent years an interested member of this Society, contributing to its proceedings a valuable and effective paper on "Why Manufacturers Dislike College Students," Vol. XVII, page 79. His personality was remarkable and those who knew him best prized him even more as a man than as an engineer. His success with young men was due to the fact that, while an uncompromising taskmaster, he recognized the value of time as an element in training, and was able to overlook the frequent personal issues which those who did not understand his methods insisted in raising at every turn. His remarkable ability to look beyond such issues and to see in them only incidents in the operation of broadening a man's view of work and duties, caused those who worked under him and understood his ideals to regard him ever after as a friend who was always ready to give to his assistants full credit for their work.

IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

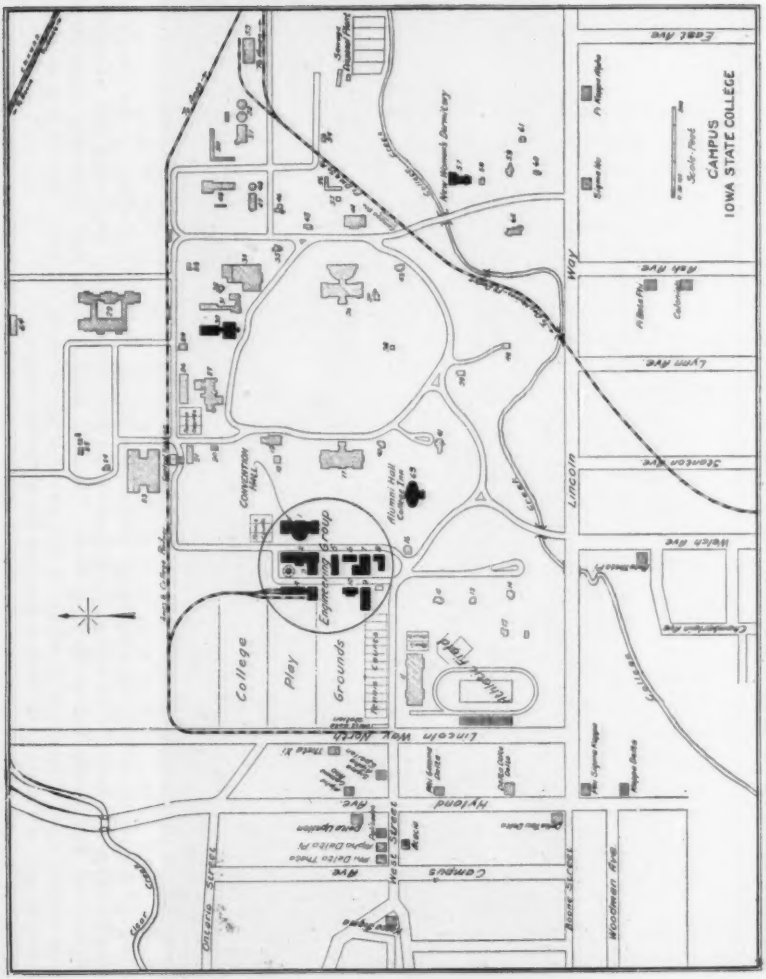
Iowa State College of Agriculture and Mechanic Arts belongs to that unique group of educational institutions commonly known as "land grant colleges." It was established by the state of Iowa some fifty years ago under the provisions of the Morrill act and those who established it intended that it should devote itself to the industries and particularly to agriculture and mechanic arts. Its educational work has been different, therefore, through all the years because of this peculiar purpose to serve the industries of the state of Iowa. It has grown to be a great college of applied learning. While it gives due place to the essential cultural subjects, its chief purpose is to train men for the fields of agriculture, engineering, industrial science and veterinary medicine and in addition to fit women for the ever widening field of home economics.

Seventeen four year courses of the highest college grade constitute the main part of the work of the institution. The entrance requirements to all these courses are graduation from an accredited four-years' high school course, the same standard entrance requirements, in fact, which generally are in force in the state universities of the country.

The service of the college to the state has not been limited to its work with students on the campus. It maintains several experiment stations and research laboratories where investigations are carried on with the needs of the farm, factory, railroad and the home always in view. Besides that, it has carried its work in all lines to the everyday folks who cannot come to college, through an extension service which last year reached more than a half million men, women, boys and girls outside.

On the campus the educational work of Iowa State College runs along five general lines, agriculture, engineering, home economics, industrial science and veterinary medicine.

BIRDS-EYE VIEW OF IOWA STATE COLLEGE CAMPUS TAKEN FROM 225 FT. CONCRETE CHIMNEY. In the foreground the agricultural buildings and barns; in the central background the administration building, Enginering Hall laboratories and shops; Agricultural Engineering Hall at the right center; Chemistry Building at the right background; veterinary buildings at the extreme right. The extent of campus in this picture is approximately 125 acres. The woods in the right background occupies part of College Park which is also used for a forestry reserve.


CAMPUS
IOWA STATE COLLEGE
College
Play
Grounds
Lincoln Way North
Lincoln Way
Hyland Ave
Campus Ave
Osborn Street
Beach Street
Woodman Ave
Lynn Ave
Stanton Ave
Welch Ave
Cedar Ave
Ash Ave
Knapp Hall
Alumni Hall
Engineering Group
Athletic Field
Scale-Feet

LIST OF COLLEGE BUILDINGS.

1. Engineering Hall.
2. Engineering Annex.
3. Ceramics Building.
4. Transportation Building.
5. Pattern Shop.
6. Foundry.
7. Steam and Gas Laboratory.
8. Structural and Hydraulics Laboratory.
9. Machine Shop.
10. Forge Shop.
11. Gymnasium.
12. Women's Dormitory.
13. Residence.
14. Residence (Dean Marston).
15. Residence.
16. College Hospital.
17. Central Building.
18. Book Store and Post Office.
19. Morrill Hall.
20. Residence.
21. Emergency Laboratory.
22. Trolley Station.
23. Chemistry Building.
24. Residence.
25. Horticulture Barns.
26. Home Economics Building.
27. Margaret Hall (Women's Dormitory).
28. Residence.
29. Veterinary Buildings.
30. Agricultural Engineering Building.
31. Horticulture Greenhouses.
32. Residence.
33. Residence.
34. Plant Industry Building and Greenhouses.
35. Residence.
36. Agricultural Hall.
37. Residence.
38. Campanile.
39. Music Hall.
40. Superintendent's Office.
41. Residence.
42. Superintendent's Store Room.
43. Residence.
44. Dairy Building.
45. Residence.
46. Residence.
47. Horse Barn.
48. Judging Pavilion.
49. Cattle Barns.
50. Hog Barn.
51. Agricultural Experiment Station Barn.
52. Judging Pavilions.
53. Central Power Station.
54. Hog Barn.
55. Residence.
56. Sheep Barn.
57. New Women's Dormitory.
58. Residence.
59. Residence.
60. Residence.
61. Women's Dormitory.
62. President's Residence.
63. Alumni Hall—College Inn.
64. State Serum Laboratories.

In all these divisions standard four-year college courses are offered, of character and with entrance requirements the same as in the Universities of Wisconsin, Illinois, and other standard technical schools.

Graduate work is offered in all lines.

By coöperative arrangements five-year courses can be taken leading in four years to a bachelor's degree in science, and to a technical degree in five years.

For the professional degree of C.E., M.E., etc., five years successful outside practice after graduation from a standard engineering school are required, together with a satisfactory thesis.

In all of these courses there has been rapid expansion in the past five or ten years, Iowa State College enjoying its measure of the great trend of young men and women toward institutions of a technical character. At the present time the institution enrolls more students than any other educational institution in Iowa. For the college year 1914–1915 the enrollment will exceed 3,200, including summer session students. Excluding summer session students the number of men and women in residence for the college year 1914–15 was 2,715. The number of students in residence is 681 more than it was two years ago. If the winter short course students who come to the campus for instruction in both agricultural and other vocational subjects be counted, the total enrollment for the present college year will be considerably in excess of 4,000.

The courses offered in the division of agriculture include agricultural education, agronomy, animal husbandry, dairying, horticulture, farm management and forestry.

The instruction in engineering comprises four-year courses in agricultural engineering, ceramics, chemical engineering, civil engineering, electrical engineering, mechanical engineering, mining engineering and structure design, and five-year courses in agricultural engineering, civil engineering, electrial engineering, mechanical engineering and mining engi-

ENGINEERING GROUP. Engineering Hall at the right; Structural and Hydraulic Laboratory at extreme left, and then in their order to the right, Steam and Gas Laboratory, Foundry, Pattern Shop, Engineering Annex and Ceramics Building. In the rear, not showing, are the Machine Shop, the Forge Shop and the Transportation Building.

neering. Agricultural engineering is administered jointly by the deans of engineering and of agriculture.

No one division of the college has grown more rapidly than the home economics division. In the college year 1911–12 the home economics courses enrolled a few more than 200. The following year the enrollment was about 350. For the year 1914–15 the total was 520.

The home economics courses include instruction in the sciences and arts that have to do with home-making, cooking, sewing, house planning and decoration, care of children, diet for the well and the sick, textiles and their care, hygiene and sanitation. There is also offered in this division a two year course for young women who have not completed high school work. The course is known as the home-makers course.

Closely linked with all these specialized technical courses is the division of industrial science. It furnishes the fundamental scientific instruction for all the other courses and in addition offers special courses of its own, designed to train men to become experts along industrial science lines. The courses offered give opportunity for special preparation in bacteriology, botany, chemistry, economics, geology, mathematics, physics and zoology.

Special coöperative five-year courses are offered in science and agriculture, science and engineering, science and home economics.

The division of veterinary medicine offers a four-year course, and, in coöperation with the division of industrial science, a combined science and veterinary course of six years in length. The degree of Doctor of Veterinary Medicine is conferred upon the completion of the four-years' course.

In connection with the veterinary division the state maintains large biological laboratories for the investigation and manufacture of hog cholera serum. These laboratories are also devoting themselves to the task of dealing with every destructive live stock disease in the state.

Along with the development of strong educational work

AGRICULTURAL ENGINEERING HALL WITH PART OF THE HORTICULTURAL AND BOTANY GREENHOUSE EQUIPMENT AT THE RIGHT. Here is probably to be found the most extensive equipment in agricultural engineering of any institution.

the state of Iowa has also developed effective experiment stations and more recently laboratories for the investigation and study of animal diseases. The agricultural experiment station, established a good many years ago, maintains at present a staff of some 45 people.

The work of the engineering experiment station was described in the April BULLETIN.

No branch of the work at the college has grown more rapidly than its extension work. A statement concerning the engineering extension service appeared in the April BULLETIN. The agricultural extension work, which was established ten or twelve years ago, is very broad in its scope. Last year it held hundreds of short courses in as many communities of the state, it maintained an extension staff of nearly 50 people, it conducted an aggressive work among boys and girls and in all reached practically a half million people in their home communities.

The college is located on a domain of nearly 1,500 acres. Of this, 175 acres comprise the campus proper. The remaining part, something over 1,200 acres, is given up largely to the college and experiment station farms, while a considerable body of it is in timber in use as a forestry reserve for the benefit of the students in forestry. Less than 50 years ago the 175 acres of campus was a stretch of rolling prairie without more than a scanty, scrubby growth of natural timber upon it, bordering several streams or creeks that made their way across this tract of land. That the campus is now covered with beautiful trees of many varieties is due to the foresight of the first president, A. S. Welch, who had special training as a landscape gardener. Today the campus is one of the beautiful spots of Iowa. Recently O. C. Simonds, of Chicago, said that it might be counted one of a few very beautiful campuses in the United States. Mr. Simonds is now retained to carry on the work of further beautification of this plot of ground.

VIEW OF THE CENTRAL PORTION OF THE CAMPUS, with Central Building at the left center and the Campanile at the right center.

Upon the campus are 45 different buildings used for educational purposes and in addition many barns and small structures used in the work of the college farm and agricultural experiment station. These buildings are for the most part new, very few of the buildings of the first twenty years of the college's existence still remaining. The main buildings, including central building, agricultural hall and engineering hall, are built of stone. The laboratories, shops and the smaller buildings are, for the most part, of brick. All the newer structures are fireproof in construction.

The equipment for all of the divisions is complete and in the engineering division this is especially true. Among the recent additions to the equipment for engineering students is a locomotive testing laboratory, one of the few of its kind in the country.

The teaching faculty, and the extension and experiment station forces number more than 350 members. Under the administration of President R. A. Pearson, who came to the college from New York two and one half years ago, they have been developed into a unified, enthusiastic group of workers who make the college a great force for a better Iowa.

During the present year the total funds available for the college amounted to $1,250,687, of which about $604,000 was for collegiate support, $292,000 for experimental and extension work, and $355,000 for buildings.

The total inventoried valuation of the college on June 30, 1914, was $3,360,000, of which about $2,370,000 was for grounds and buildings, and about $990,000 for equipment, furniture and supplies on hand.

The engineering faculty numbers 55, the experiment station staff 24, and the engineering extension staff 8. Exclusive of duplicates there are 72 technically trained men devoting full time to instructional, experimental or extension work. The salaries aggregate $117,300, and the department expenses $34,250. The engineering experiment station and the engi-

AN OPEN-AIR CONVOCATION OF THE STUDENT BODY AT IOWA STATE COLLEGE, with Central Building and Engineering Hall in the background. This group comprises 2481 members of the student body and faculty, numbering approximately 3000.

neering extension department each have $25,000 annually of the above for the support of their work.

The engineering buildings are valued at $515,805, and their equipment and supplies at $210,368. The buildings can be briefly described as follows:

Engineering Hall is a four-story Bedford stone, fireproof, building, 75 ft. by 208 ft., with a three-story semi-circular projection at the rear.

Agricultural Engineering Hall is a four-story brick and stone building, 64 × 104 feet, with an annex 60 × 100 feet.

Structural and Hydraulic Laboratory is a three-story stone and brick building, one wing 30 × 90 and another 25 × 30.

Engineering Annex is a three-story fireproof brick building, 50 × 208 feet.

Ceramics Building is a three-story fireproof brick building, 40 × 50 feet.

Mechanical Engineering Laboratory is a two-story fireproof building of brick, steel and concrete. The main part is 55 × 165 feet, and the wing is 55 × 45 feet. A 128-feet brick stack adjoins.

Transportation Building is of fireproof brick construction and comprises two wings, one 50 × 100 feet and three stories high, the other 43 × 120 feet, one story.

Machine Shop is a two-story fireproof brick building, 45 × 150 feet.

Foundry is a one-story brick dwelling, 38 × 78 feet.

Forge Shop is a one-story brick building, 38 × 78 feet, with store room addition.

Pattern Shop is a one-story brick building, 40 × 120 feet.

Iowa State College has this year again reached its maximum collegiate engineering enrollment of 704 for the year 1907–8. The enrollment by departments this year is as follows:

Agricultural engineering	121
Ceramics	4
Chemical engineering	24
Civil engineering	174
Electrical engineering	205
Mechanical engineering	147
Mining engineering	12
Structure design	27
Total of collegiate grade	714

In addition to the above there are 61 students taking trade school work throughout the year under the direction of the engineering extension department.

COÖPERATIVE COURSES IN ENGLISH FOR ENGINEERING STUDENTS.*

BY C. W. PARK,

Assistant Professor of English, University of Cincinnati.

It is said that at a conference of history teachers not long ago, reference was made to history in the high school as a "snap course"; whereupon one teacher jumped to his feet and indignantly resented the imputation. "History a snap!" he shouted, "On the contrary, it is one of the hardest subjects in the curriculum. Why, as I teach history, no subject could possibly be more difficult and confusing."

I do not claim so much for my method of teaching English composition; nor do I insist upon it as *my* method, for so far as I am aware, it includes nothing startlingly original. My impression is, that like many other educational ideas which have been favorably received as theory, it has been neglected in practice because of real or fancied administrative difficulties. I do not of course assume to speak ex cathedra regarding the adaptation of the plan to the teaching of composition in other colleges or in high schools. Whatever applications may be made, or for that matter, are already being made, the discussion will show. As requested by the chairman, I shall confine myself to a fairly concrete description of one way in which a specific problem in the teaching of English composition was met. But first it should be explained that this problem in composition teaching was only one phase of a larger problem in technical education.

The organization of the coöperative course in engineering at the University of Cincinnati involved a new definition of the functions of each branch of the study, and an investigation of

* A paper read before the English Section of the Ohio Teachers' Association at Columbus, Ohio, December 30, 1914.

the interrelations between affiliated subjects. The engineering faculty met frequently as a committee of the whole for the discussion of these questions, and for such revision of the curriculum as seemed necessary under the new plan. Attention was paid at first, not to the amount of time that should be given a subject, nor to its place in a graded series, but rather to the fundamental question, what was it intended to accomplish? In other words, why was it included at all? If the existence of a course could be justified, the next question was, how could it be taught most effectively in the shortest time, in order to accomplish its purpose? The need for conservation of time and effort led to an appraisal of the subject matter in each course, to distinguish the essentials from the relatively unimportant details which had been taught from year to year, purely out of respect for tradition. The field was staked off anew and some interesting cases, both of overlapping and of deficiency, were uncovered. A closer connection was established between related courses—especially prerequisite and advanced studies—and this resulted in a kind of *internal coöperation* as between departments. Instructors planned their courses together to make them dovetail into one another, and by means of a provisional grade system, students were compelled to show that they retained a working knowledge of prerequisite subjects. Certain advanced courses were especially planned to detect weaknesses in a student's knowledge of the fundamentals—for example, of calculus in bridge design—and thus to serve as a check, both on the individual student and on the instruction given during the first part of his university training. In keeping with the theory of cooperative education, the chief test applied in all the criticism and reorganization of courses was the immediate or ultimate value of a subject to the engineer in his professional and civic life.

Theoretically, it was not hard to justify the existence of English composition in any program for the training of engineers. Composition had or was believed to have, a twofold value, cultural and practical, and there was accordingly a

double reason for keeping it in the curriculum. When, however, the course was tested for efficiency, the evidence showed that it was not filling the place assigned to it. Leaving aside all tests of culture, it was found that the course in composition had no conspicuous practical value. Employers of graduates complained that the young engineers could not compete with unschooled apprentices in the writing of reports and business letters. Instructors in non-English courses declared that the only way they could tell whether a student had "had" English composition was to look up his record. They could never guess it from his writing. His English seemed perfectly insulated against any live contact with his other subjects. In fact, it was clear that however desirable the course in composition might be in theory, it had fallen far short of meeting the simplest practical requirements.

The remedy for this condition was naturally suggested by the most pronounced defect which it exposed. Composition must be brought into closer and more vital relation with other subjects and with the practical work which the student was to do, or which, in fact, the coöperative students were already doing. It was desirable, however, that this emphasis on the vocational side of composition should not be made at the expense of the cultural side, and that if possible, a part of the time hitherto devoted to practical work should be given over to literature and to literary composition. The one plan which promised both an extended application of practical English and a saving of time for liberal English, was that of coöperation with teachers of non-English subjects. In several of the technical courses a considerable amount of written work was regularly being done, and it was this use of English as a tool which furnished the most satisfactory test of the student's working knowledge of composition. Here he was not writing English for the sake of a grade in English—a very different thing from art for art's sake—but was striving to express in English his ideas on a variety of subjects. His characteristic weaknesses and points of strength, especially in such fundamental matters as organization of thought, sentence structure,

and vocabulary, could thus be observed to better advantage than in a special course in which the technique of expression was consciously studied as an end in itself.

The written work done in the non-English courses could be classified in various ways, but from the standpoint of administering a coöperative system, it was preferably considered under two main heads: first, *occasional compositions*, ranging from impromptu quiz papers to ten-page reports in connection with shop or field work; and second, *regular reports*, scheduled as a fixed part of the requirements in shop and laboratory courses. For several reasons, the regular reports were chosen as the basis of coöperation. In the first place, it was possible to establish a definite routine for the interchange of such reports between departments, and thus with a minimum of administrative effort to keep a constant check on the writing of a large number of students. The fact that these reports dealt with what may be called descriptive subjects, and were, therefore, less technical than the occasional compositions, made it possible for the instructor in English to learn the vocabulary and to become sufficiently familiar with the content of the reports to criticize them intelligently. An equally important advantage, which may seem at first an objection, lay in the standardized, and in some cases almost stereotyped, form of the regular reports. The recurrence of essentially the same problems of expression in a series of compositions afforded opportunity for drill in the fundamental principles of writing. Despite the general similarity between reports for a given period and in a given subject, however, there was sufficient variety as between the different periods and subjects to develop new problems of composition. The further fact that the regular reports were almost evenly distributed over the five years of a student's course, made them admirably suited to the plan of coöperation. The coöperative course in English composition, therefore, had for its principal feature the weekly examination and criticism of regular reports written in the non-English courses.

A few specific examples may be cited to show the kind of

subjects which have been found to lend themselves most readily to coöperation with English. In connection with the first year's work and in a technical study known as "coördination," the students visit six industrial plants or engineering projects; for example, a foundry, a machine shop, a power plant, a filtration plant, a chemical plant, and a viaduct or sewer under construction. Each trip is reported in a composition of from one thousand to two thousand words. The report is written in accordance with instructions supplied respectively by the department of coördination, which emphasizes the subject matter, and the department of English, which emphasizes the form. After the student has written his report, he submits it to the department of English for criticism, after which he corrects or re-writes it until he has brought it up to a passing standard in English. The grade in English is recorded, and the report is then turned over to the department of coördination. After it has been graded for subject matter, it is returned to the student. A similar plan is followed in the case of the long reports in chemistry, the coördination papers in civil engineering, and the laboratory and inspection-trip reports which are written in connection with courses in mechanical and electrical engineering. In some of the advanced courses the routine is reversed, the reports going first to the technical, and later to the English, department. As a rule, the upperclassmen, having had considerable drill in the beginning, maintain a pretty high standard of expression; but in case a report is notably poor in English, the instructor in the technical subject lays it aside to be rewritten The more important "occasional" papers are also handled in this way, so that although regular criticism of English is based on one class of compositions, practically all the written work comes under the general supervision of the department of English. Indirectly, at least, all of a student's writing is influenced by the coöperative courses in composition, and the connection is made the closer by the blanket ruling of the faculty that no written exercise in any subject or in any term will be accepted unless it is up to the passing standard of expression.

The outline for the first-year course in composition will serve to illustrate the way in which the coöperative idea is carried out. This course, known as English 41, is given in connection with the two non-English courses, coördination and chemistry. The outline, which is here summarized in the regular form adopted for all synopses of courses in the College of Engineering, consists of the three main divisions: object, method, and matter.

ENGLISH 41.

Given in Connection with Coördination 1, 2 and 3, and Chemistry.
Prerequisite—Entrance Requirements in English.

Object.

To develop the ability to organize material into a clear and comprehensive report.

To review and apply the principles of composition.

To discover weaknesses in the writing ability of individual students.

To correct faults in expression, particularly in such matters as paragraphing sentence structure, spelling, and punctuation.

To increase the student's vocabulary and to make him more accurate in the use of words.

Method.

Lectures on the principles of composition as applied to the writing of reports.

Written instructions to guide the student in writing reports.

Examples of good and bad form in inspection trip reports.

Criticism of reports by the instructor and the class.

Revision and rewriting of reports by the students.

Conferences with individual students.

Additional study and practice required of those students who show poor preparation in English.

Technical terms supplied and explained by the Department of Coördination.

Credit given for form as well as for content in all written work, regardless of the branch of study involved.

Matter.

The whole composition and the paragraph.
- Subject.
- Purpose.
- Material.
- Organization.
  - Unity.
  - Coherence.
  - Emphasis.

The sentence.

Vocabulary.
- Technical terms.
- General and specific words.
- Spelling.
- Punctuation.
- Abbreviations.
- Use of figures.
- Style in engineering reports.

Standardization of mechanical details, such as covers, margins, paragraph indentations, position of titles and headings, writing of formulas and chemical equations, placing of sketches and endorsement of manuscripts.

In a fourth column, headed *Administration,* are included the following details:

Administration.

All reports graded for English as well as for subject matter.

On a blackboard record, reports are checked when received, and grades in English are recorded before the reports are passed on to the Department of Coördination.

Card catalogue of individual students contains record of the following details for each report:

Organization.
Sentence structure.
Vocabulary.
Spelling.
Punctuation.
Manuscript.
Grade in English.

Sketch required with each report.

Manuscripts written on uniform paper and bound in standard manila covers.

Students meet regularly in groups of six to eight for the criticism of reports.

It will be observed that the operation of the course just outlined is made as nearly automatic as possible. Smoothness of administration is perhaps the chief essential to success in cooperative courses, and it is for this reason that only the regular written exercises were considered in the organization of the course. It will also be noted that in the division called *Matter,* a portion of the theory usually taught in separate English composition courses is included. By distributing the theory in this way through the various coöperative courses, considerable time is saved for literature and literary composition in the regular course in English.

Before leaving the subject, I wish to take notice of the objection which has been most frequently raised against coöperative courses in English for engineering students; namely, that the instructor must be that almost impossibly rare combination, a technical man and a teacher of English. The experience of several years has convinced me that no such necessity exists. The instructor in English should of course be industrious enough to master a new form occasionally; but he will find the form of the engineering report no more difficult or technical than the form of the brief in argumentation. He should be patient enough to endure the drudgery of routine; but where is the conscientious teacher of any subject who escapes such drudgery? He should be capable of grasping

readily the peculiarities and difficulties of individual students; but in the sympathetic criticism, even of technical reports, he will find variety and personality. Above all, he should be adaptable; but so should he be, regardless of the brand of composition he essays to teach. If he possesses anything like the versatility required of a successful teacher of composition, he will not be frightened by a few technical terms, and he will be liberal enough to interest himself, at least vicariously, in some of the subjects outside his special field.

Tested by its results, the coöperative plan of teaching English composition has already earned a fixed place in the program of technical education at the University of Cincinnati. Its justification in theory should be obvious enough. Composition is primarily an *applied subject;* that is, it must be taught concretely, rather than abstractly. It seems only reasonable, then, that a part of it should be taught in terms of familiar and useful applications.

SUGGESTED COLLEGE COURSE ON THE HUMAN SIDE OF ENGINEERING.

BY FRED H. RINDGE, JR.,

Sec't. Industrial Service Movement.

This outline has been prepared by request with the help of some leading engineering professors and business men. It is arranged to cover 32 or 64 class periods—four months or eight months work at the rate of two periods a week. Certain topics may be omitted or the number of assigned periods be lessened where time is lacking. This is merely a rough preliminary outline. *Suggestions on subject matter and references will be greatly appreciated.* The course should be supplemented by engineering trips to study certain industrial conditions and the betterment work of selected companies and social agencies. This is *not* a course in sociology and economics. It is a course in engineering and must be given by an engineering professor of large practical experience. Other members of the faculty, selected engineers, labor leaders or others may be requested to give certain periods, as desired.

1. INTRODUCTORY—THE HUMAN FACTOR IN INDUSTRY.

Two periods. Showing in an interesting way that men comprise the most important element in any industrial operation. The dignity of labor. In the past machines and processes have been given much more attention than has the human factor. This condition is rapidly changing. Do we realize that one of the greatest elements of success is the ability to deal intelligently with men?

References: *Adams & Sumner: Labor Problems.
Scott: Increasing Human Efficiency in Business.
*Tolman: Social Engineering.
*Redfield: New Industrial Day.
Wood: The Political Economy of Humanism.
Carlton: The Industrial Situation.

2. HISTORICAL—THE EVOLUTION OF THE INDIVIDUAL WORKER IN INDUSTRY.

From two to four periods. A brief summary of the history of industry with special reference to the influence of changing conditions upon the human factor. Industrial Evolution—The changes from serfdom to individual trades, to the use of machinery, to the modern factory system, the rise of labor organizations, etc.

References: Bucher: Industrial Evolution.
Gibbins: Industrial History of England.
Moore: Industrial History of the American People.
Carlton: Educational and Industrial Evolution.
Comam: Industrial History of the United States.
Bogart: The Economic History of the U. S.
Dyer: Evolution of Industry.

3. INDUSTRIAL ORGANIZATION—THE INFLUENCE OF THE MODERN FACTORY SYSTEM ON THE WORKER.

Three to five periods. General and departmental organization. Management. The relation of wages, hours, etc. The interdependence of men. Should foremen, superintendents, managers, etc., be chosen on the ground of their ability to deal sympathetically and successfully with men? Which forces are beneficial and which detrimental?

References: *Diemer: Factory Organization and Administration.
Brisco: Economics of Business.
Brisco: Economics of Efficiency.
Taylor: Shop Management.
*Taylor: Modern Factory System.
Emerson: Efficiency.
Nicholson: Factory Organization and Costs.
Kirschbaum: Business Organization and Administration.
Hine: Modern Organization.
Ennis: Works Management.
*Price: The Modern Factory.
Going: The Principles of Industrial Engineering.
Hartness: The Human Factor in Works Management.
Carpenter: Profit Making in Shop and Factory Management.

4. HUMAN FACTORS IN PRODUCTION.

(a) *From six to sixteen periods.* Problems to be solved. General: Capital and labor, immigration, unionism, socialism, syndicalism, anarchy and the I. W. W., etc. What shall be our attitude toward these great questions?

References: *Carlton: The History and Problems of Organized Labor.
Eliot: Future of Trades, Unionism and Capitalism in Democracy.
Henderson: Industrial Insurance in the U. S.
Seager: Social Insurance—A Program of Social Reform.
Brooks: The Conflict between Private Monopoly and Good Citizenship.
Wyman: Control of the Market—A Legal Solution of the Trust Problem.
Hobson: Evolution of Modern Capitalism.
Gladden: The New Idolatry.
*Mitchell: Organized Labor.
Brooks: Syndicalism and the I. W. W.
Lewis: Syndicalism and the General Strike.
*Letters from a Workingman—by an American Machinist.
Ely: Labor Movement in the United States.
Bolen: Getting a Living.
*Webb: Industrial Democracy.
Commons: Trade Unionism and Labor Problems.
*Roberts: Immigrant Races in North America.
Roberts: The New Immigration.
Holt: Undistinguished Americans.
Steiner: On the Trail of the Immigrant.
Steiner: The Immigrant Tide.
Steiner: The Broken Wall.
Steiner: From Alien to Citizen.
Jenks & Lauck: Immigration Problems.
Antin: The Promised Land.
*Daly: Carmina.
Daly: Madrigali.
Reports of Commissioner General of Immigration.
Report of State Immigration Commissions, etc.
Rauschenbusch: Christianizing the Social Order.
Kirkup: History of Socialism.
H. G. Wells: New Worlds for Old.
*Hilquit: Socialism in Theory and Practice.
Dealey: Sociology.

*Stelzle: The Church and Labor.
Thomson: The Churches and the Wage Earners.
Adams: The Theory of Social Revolutions.
*Publications of American Association for Labor Legislation.
Brooks: Corruption in American Politics and Life.
Kelley: Ethical Gains Through Legislation.
Pigon: Principles and Methods of Industrial Peace.
Ward: Social Creed of the Churches.
Men and Religion Movement Messages.

(*b*) *Working Conditions.* Hours, wages, industrial accidents, their prevention, industrial disease and its prevention, unsanitary environment, child labor, "blind-alley" employments, compensation, etc. What are determining factors in the efficiency of the individual man? Do right conditions pay?

References: Mangold: Child Problems.
Nearing: Solution of the Child Labor Problem.
Nearing: Wages in the United States.
*The Survey Magazine and its Publications.
Publications of National Child Labor Committee.
More: Wage Earners Budgets.
Butler: Women and the Trades.
Abbot: Women in Industry.
Annual and special reports of the Department of Labor, Nos. 53, 77 and others, Washington, D. C.
Goldmark: Fatigue and Efficiency.
Ryan: A Living Wage.

(*c*) *Living Conditions.* Housing, proper nourishment, poverty, home refinements, home-gardens, thrift and savings, etc. What relation has health to efficiency? Can a "home-garden" have any effect on a man's work in the shop?

References: Gilman: The Home.
Chapin: The Standard of Living among Workingmen's Families in New York City.
Streightoff: The Standard of Living among Workingmen's Families in America.
Veiller: Housing Reform.
Greene: Among School Gardens.

*Devine: Misery and its Causes.
*Devine: The Family and Social Work.
Hobson: Problems of Poverty.
Riis: How the Other Half Lives.

(*d*) *Leisure Conditions.* Amusements, intemperance, the social evil, education, etc. Why is "big-business" interested in these things? Industry's efforts to put a premium on temperance and character.

References: *Edwards: Popular Amusements.
*Addams: The Spirit of Youth and the City Streets.
*Perry: Wider Use of the School Plant.
Peabody: The Liquor Problem.
*Mero: American Playgrounds.
Koren: Economic Aspects of the Liquor Problem.
Bagnall: Economic and Moral Aspects of the Liquor Business.

The responsibility of the employer; the responsibility of the technical engineer. The relation of the technical engineer to his employer as well as to his employee. The ethics of engineering.

Note.—In both 5 and 6 special application may be made to various industries: Lumber, mining, textile, railroading, etc.

5. VOCATIONAL GUIDANCE AND THE EDUCATION OF EMPLOYEES. *Two to four periods.* What is our attitude toward vocational training? Should boys and men be trained for a job or for life? Methods of education of foreign employees, American men and apprentices, corporation schools, public night schools, correspondence study, special methods of various agencies, etc. To what extent does improving a man's education increase his efficiency?

References: Wright: The Apprenticeship System in its Relation to Industrial Education.
Ware: Educational Foundations of Trade and Industry.
*Dean: The Worker and the State.
*Blackford: The Job, the Man, the Boss.
*Bloomfield: The Vocational Guidance of Youth.

*Robinson: The Wage Earning Boy.
Carlton: Education and Industrial Evolution.
Snedden: The Problem of Vocational Education.
Travis: The Young Malefactor.
Weaver: Profitable Vocations for Boys.
Davenport: Education for Efficiency.
Hanus: Beginnings in Industrial Education.
Leavitt: Examples of Industrial Education.
U. S. Bureau of Education bulletins.
U. S. Bureau of Labor bulletin No. 54 and others.
Publications of National Society for Promotion of Industrial Education, 140 W. 42d St., N. Y.

6. Coöperative Organizations.

Two to four periods. National Civic Federation, National Council for Safety, Russell Sage Foundation, National Society for Promotion of Industrial Education, The Young Men's Christian Association, and other organizations dealing specifically with problems above outlined. Proposed solution etc. (For a list of 100 such agencies see "Ways and Means," a handbook of industrial betterment work of the Y. M. C. A., Association Press, 124 East 28th Street, New York City, 15 cents.)

References: *Henderson: Modern Methods of Charity.
Conyngton: How to Help.
Devine: Principles of Relief.
*Addams: Twenty Years at Hull House.
*Publications of agencies indicated above.

7. Legislation and Public Opinion on Industrial Questions.

Two to four periods. To what extent have welfare requirements been incorporated in Federal and State laws? Important specific laws and their influence. What are the benefits and limitations of legislation? To what extent is public opinion a determining factor?

References: *Rauschenbusch: Christianizing the Social Order.
Hall: Social Solutions in the Light of Christian Ethics.
The Gospel of the Kingdom—Published monthly.

*Publications of American Association for Labor Legislation.
Brooks: Corruption in American Politics and Life.
Kelley: Ethical Gains Through Legislation.
Pigon: Principles and Methods of Industrial Peace.
Ward: Social Creed of the Churches.
Men and Religion Movement Messages.

8. THE PROGRAMS OF TYPICAL COMPANIES. INDUSTRIAL BETTERMENT.

Five to ten periods. What has been and can be done along such lines as indicated above. The relation of all such work to efficiency and happiness. Legislation and coöperation. Examples: Typical programs of the entire betterment activities of selected companies. Why has the U. S. Steel Corporation spent $7,000,000 in improving the conditions of its employees? Are such companies actuated by economic or human motives, or both?

References: *Hall: Social Solutions in the Light of Christian Ethics.
Fay: Co-operation at Home and Abroad.
Meakin: Model Factories and Villages.
U. S. Bureau of Labor, Bulletin Nos. 54 and 123.

9. SCIENTIFIC MANAGEMENT.

Two to five periods. Principles, importance of motion study, time study, division of labor, etc. The human *relations in the system.* The idea of using efficiency systems to help men rather than to grind them down. How to get the men to understand this, etc. The efficiency with which "efficiency" is applied.

References: Brisco: Economics of Efficiency.
Taylor: Shop Management.
Taylor: Modern Factory System.
Emerson: Efficiency.
Ennis: Works Management.

10. HOW TO HANDLE MEN.

Four to eight periods. (To be given by specialists.) Examples of industrial leaders who have been successful

in handling men—Gary, Westinghouse, Perkins, Ford, etc. Was their success due largely to this ability? How did they develop it? The hiring and firing of workers. The American working man, the working boy, the foreign laborer, and the colored worker. How to understand the human factor, and to learn how to handle men, etc. The Industrial Service Movement idea.

References: Williams: Some Successful Americans.
Parton: Captains of Industry.
Special Publications of the Survey Magazine.
Special Publications of the American Federation of Labor.
Scott: Increasing Human Efficiency in Business.
*Redfield: New Industrial Day.
Hartness: The Human Factor in Works Management.
Holt: Undistinguished Americans.
*Oppenheim: Doctor Rast.

11. CONCLUSION—THE ENGINEER'S RESPONSIBILITY FOR SERVICE.

Two periods. In the light of the above what will be your attitude as you graduate? Will your life purpose be wealth regardlness of others, or wealth of service for others? Self-interest or social interest?

References: Robinson: Christian Teaching on Social and Economic Questions.
*Rauschenbusch: For God and the People: Prayers of the Social Awakening.
Balch: Christianity and the Labor Movement.
Ellwood: Sociology and Modern Social Problems.
*Henderson: Social Duties from a Christian Point of View.
*Taylor: Religion in Social Action.
*Gilman: Methods of Industrial Peace.
*Hall: Social Solutions in the Light of Christian Ethics.
*Strong: Our World: the New World Life.

THE CURRICULUM OF THE MINING SCHOOL.

FRANCIS A. THOMSON,

Head of Department of Mining Engineering, The State College of Washington.

Mining is one of the two great basal industries—the other is agriculture. From the point of view of the individual, mining is the business of *making money* out of minerals. From the point of view of civilization as a whole, mining is the business of *producing minerals,* and must continue whether the individual gains or loses.

The function of the mining engineer is to direct and to facilitate the production of those portions of the earth's crust which are of use and benefit to mankind. His work falls naturally into three great divisions. The first is the search for new bodies of mineral, or for the continuation of old ones, —prospecting. This search may be carried out on the surface or underground; its intelligent prosecution depends upon a knowledge of the science of geology, coupled with some principles of engineering practice. The second—mining proper—is the problem of extracting the mineral after it is found. This is strictly an engineering problem, involving the use of water-power, electric-power, steam, compressed-air, and other prime-movers; the application of explosives; the principles of structural design, of surveying and in short of almost every form of engineering knowledge. The third has to do with the extraction of the valuable ingredients from the ore or mineral, for with the exception of coal and clay, few minerals can be mined ready for use. This division is largely one of chemical technology. The extraction of metals from their ores—*i. e.* metallurgy—comprises an art distinct from other phases of chemical technology and is rather the field of the mining engineer and metallurgist, than of the chemist.

CURRICULUM OF THE MINING SCHOOL.

The training of the mining engineer must primarily be such as to give him a foundation in chemistry, physics, mathematics, English, and economics, and must be followed by at least the rudiments of civil, mechanical and electrical engineering. To this large order must be added whatever of specialized professional training the student is to receive along mining and metallurgical lines. From this it will be fairly evident that the educational training of the future mining engineer, due to its diversity and complexity, offers more serious difficulty than is presented by any other line of engineering education. This difficulty may be resolved into two phases, (1) that of preserving a proper balance and distribution of the student's time between the various fields of knowledge with which he must be made acquainted, and (2) that of preventing an overcrowding of the curriculum such that not only is the student driven at a pace incommensurate with sound scholarship, but that everything except strictly technical subjects is pushed aside, and the result is an artisan rather than a future engineer and professional man.

That no general solution has been found for the first phase of the difficulty is evident when we study the various curricula in the accompanying diagram. The second phase—the crowding and driving—is especially the problem of the separate, isolated schools of mines, although on the face of it the mining departments of several great universities appear to have fallen into this error also, in their case, however, the student gains much from the great broadening influence of university life, which like many other (some would even say most) of the best things, does not appear in the curriculum. Another attempt to relieve the overcrowding is evidenced by the five and six year courses being offered by three or four of the larger universities. It is premature as yet to venture any conclusion in regard to these, and their progress will be watched with interest. Excluding these courses, it is evident that the problem as a whole is one of the distribution of time and effort, and to a large extent also, it is unfortunately a problem of

elimination. Not what to put in the curriculum, but what to leave out of it, is an important part of the question. The duties of the mining engineer are apt to be so omnifarious that almost any subject is likely to be useful, and it is not merely utility, but maximum utility or indispensability which must control.

Under the circumstances, it is scarcely to be wondered at, that the solutions of this problem which the different colleges offer are as varied as the men who make the schedules, but it appears to the writer that the range between maximum and minimum of time devoted to the various parts of the mining engineer's course is so great as to call for earnest and united consideration by all who are interested in the profession, whether they be teachers or practitioners. Taking each important subject, we find the following range of percentage distribution of time:

Geology.—For mining option from 23 per cent at Stanford to 7 per cent at Illinois. For metallurgical option from 18 per cent at Stanford to 2 per cent at Massachusetts Institute of Technology.

Chemistry.—For mining option from 19 per cent at Massachusetts Institute of Technology to 7.5 per cent at Pennsylvania State College and Wisconsin. For metallurgical option from 23 per cent at Sheffield to 11 per cent at the University of Washington.

Physics.—From 10 per cent at Columbia (metallurgical) to 0 per cent at Stanford.

Mathematics.—From 14 per cent at Ohio State* to 6 per cent at State College of Washington.†

Mechanics.—From 12 per cent at McGill (Mining) to 0 per cent at Stanford (Metallurgy).

* Oregon Agricultural College exceeds this, but requires only two years high school for entrance.

† A five-hour course of one year duration embracing the *essentials* of analytical geometry, and calculus *necessary* for mechanics, theoretical and applied.

Surveying.—From 13 per cent at Michigan College of Mines to 0 per cent at Lehigh, Massachusetts Institute of Technology, and Toronto (Metallurgical options).

Mechanical Drawing.—From 12 per cent at Toronto (Metallurgy) to 3 per cent at Iowa State.

Mechanical and Electrical Engineering.—From 16 per cent at the Massachusetts Institute of Technology (Metallurgy) to 0 per cent at State College of Washington (Mining). None is required at the University of California, but a suggested course includes mechanical and electrical engineering.

Mining.—From 16 per cent at Pennsylvania State College (Mining) to 0 per cent at Lehigh (Metallurgy).

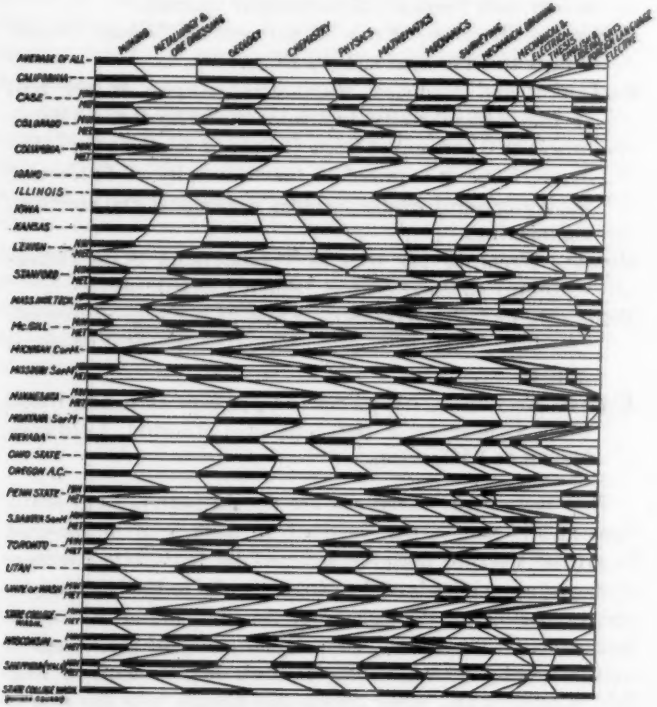
Metallurgy and Ore Dressing.—From 24 per cent at Toronto (metallurgical) to 0 per cent at Michigan College of Mines.

English, Economics, etc.—From 13 per cent at Pennsylvania State College to 0 per cent at California, Columbia, McGill and Minnesota.

That these great variations are due in part to local conditions and to some extent justified by them is of course true. In greater measure, however, they are due to the idiosynerasies of the deans and heads of departments, who in the last analysis are responsible for the makeup of the curricula in the various institutions. The general educational policy of the college or university as a whole, usually controls requirements in English, economics and other liberal arts studies. In the case of chemistry and of geology there is justification for difference in emphasis if separate options are offered in mining and in metallurgy, so also in the case of the study of mining and metallurgy as such. The variation in chemistry and geology is, however, almost as great within each option, as in the entire group. In the remaining subjects it is difficult to see any real occasion for the very great differences which exist. If those who require the maximum are right then those who require the minimum are wrong, and vice versa. The aver-

CURRICULUM OF THE MINING SCHOOL.

DIAGRAM SHOWING PERCENTAGE DISTRIBUTION OF VARIOUS STUDIES IN CURRICULA OF TWENTY-SIX MINING SCHOOLS.



Note.—The data for the above diagram are taken from the last available catalogues of each institution, the only exception to this being made in the case of Columbia University, on account of the four-year course which is used for comparison, appearing for the last time in the 1913 catalogue. All of the courses are comparable in that, with the exception of Oregon Agricultural College, all require the substantial equivalent of a good four-year high school course for entrance. There are slight differences in admission requirements as to mathematics and chemistry but these are more apparent than real. The assumption has been made except where otherwise stated, that two hours of laboratory work

is equivalent in value to one hour of lecture or recitation. The comparisons are in no case absolute, however, and minor errors have doubtless crept into the table due to the difficulty of bringing the numerous systems of cataloguing courses to a common basis.

age of such a list of variables is of little value in itself. However, a course planned on the lines of the average would be a reasonably well-balanced one, a little heavy perhaps on chemistry and a little light on geology, but on the whole reasonably satisfactory.

The new course which the writer proposes represents his best judgment at present and is submitted for constructive criticism. The question of separate courses for mining and for metallurgy is an important one concerning which there is much diversity of opinion. Of twenty-six colleges, sixteen give separate courses in mining and in metallurgy. In some cases these are not greatly dissimilar, while in others the differences are notable. It would seem that with such institutions as Pennsylvania State College, Lehigh and a few others there is justification in the fact that a large proportion of their graduates go either into ferrous metallurgy or else into coal mining, and these two industries have so little common ground in technology that a differentiation of curriculum is desirable. In the majority of the western institutions however, it is hard to see any really good reason for separate courses, since in almost all cases the graduates go into gold, silver, copper or lead producing operations, and in the first two particularly, and in the latter two to a notable extent, there is often no sharp line of demarcation between the mining and the metallurgical phases. It is also true that the undergraduate student in the majority of cases does not and can not know beforehand which side of the work he is likely to follow. For this reason, it is the writer's belief that separate curricula in mining and in metallurgy in the case of the western mining

* Only two of the three years required at Michigan College of Mines are included in this tabulation. The third year is not specified in the current catalogue.

schools is not desirable, at least until a sharper line is drawn in practice between the two sides of the profession.

In conclusion, the writer submits the following contentions:

I. That the general problem of educating mining engineers deserves more consideration and discussion than has been given to it;

II. That there is undue, unwise and unnecessary variation in the emphasis laid upon different studies of the curriculum;

III. That in the present state of the mining industry, segregation into two or more options is justified only for ferrous metallurgy and coal mining.

TEACHING ELECTRIC CURRENTS VS. TEACHING DIRECT AND ALTERNATING CURRENTS.

BY J. F. WILSON,

Instructor in Electrical Engineering at the University of Michigan.

"A deeply rooted belief seems to have been cultivated in the minds of many that phenomena connected with the flow of direct electric currents and of alternating electric currents are almost wholly unrelated. This popular idea is, however, erroneous; the principles which relate to the flow of electric currents, whether direct or alternating, and which are applied to the design and construction of machines and circuits, are one and the same."—*Extract from "Alternating Currents and Alternating Current Machinery," by D. C. and J. P. Jackson.*

The writer believes that this erroneous, but widely prevalent, belief that direct (continuous) currents and alternating currents are *not* subject to the same general laws is largely due to the manner in which the fundamental facts of electrical science are presented to the student. Direct currents are usually treated first, and an abridged theory, which is applicable to continuous currents only, is developed. This abridged theory is usually built on a statement of Ohm's Law which leads the student to incorrect conclusions. When the student comes to the study of alternating currents, this theory must be reconstructed or broadened to account for the phenomena which exist in alternating current circuits. This reconstruction of what the student conceives to be fundamental principles, but which are special applications of fundamental principles, confuses him and causes him to believe that continuous and alternating currents are governed by separate and distinct laws. Some texts go so far as to state what they term "Ohm's Law for alternating current circuits."

The general (fundamental) laws of the electric circuit are experimental facts, and are as easily developed at the *beginning* of the course as after direct currents have been studied. Their early development is desirable for the following reasons:

1. Alternating currents flow in the armature coils of direct current dynamos as well as in those of alternating current machines, and the alternating current may, therefore, be regarded as the fundamental electric current.

2. Various phenomena peculiar to direct current dynamos, notably the phenomena incident to commutation, cannot be adequately explained without a fundamental conception of inductance and its effects in an electric circuit, the current in which varies momentarily.

Very little trouble has been experienced by the writer when he emphasized, at the *beginning* of the course, the following:

1. The distinction between direct (continuous) and alternating currents.

2. The physical meaning of the terms resistance, inductance, capacitance, reactance and impedance, and their effects on the flow of electric currents.

3. The fundamental (experimental) relations of the applied electromotive force and the current flowing in an electric circuit, *i. e.*, the applied electromotive force is equal to the product of the current flowing in the circuit and the impedance (*not* the resistance) of the circuit.

4. A correct statement of Ohm's Law, which is universal and is not limited to continuous current circuits, *i. e.*, the electromotive force required to overcome the opposition due to the resistance of *any* circuit, is equal to the product of the current flowing in the circuit and the resistance of the circuit.

5. The relations between resistance, reactance and impedance which show that when the current in a circuit is constant in value, the opposition due to inductance is zero, the impedance of the circuit is equal to its resistance, and the fundamental relations reduce to the form commonly used in direct current texts, *i. e.*, when the current flowing in an elec-

tric circuit (any circuit) is constant, the applied voltage is equal to the product of the current and the resistance of the circuit.

The student is thus shown that continuous and alternating current circuits are subject to the same general laws; that the simpler expression used for continuous current circuits is due to conditions in the circuit which reduce certain factors in the general expression to zero; and the difficulties met in working from special to general conditions are eliminated.

ANOTHER SHOT AT DESCRIPTIVE GEOMETRY.

Including a Presentation of the Two General Methods of Descriptive Geometry, Their Development, and Their Fundamental Relationship to Drawing.

BY CHAUNCY WERNECKE,

Civil Engineer, Seattle, Washington.

As seen by the February Bulletin descriptive geometry is still being nursed by some teachers of engineering. Doubtless the subject has a wide interest since many of the older men in the engineering schools have at some time taught it, and the present force of instructors teaching drawing comprise a large number of any engineering faculty. The writer is prompted to finish an article which he has had on hand since his experience in teaching the subject a few years ago.

The importance of descriptive geometry, as the writer sees it, lies in the possibility of being able to reduce the time now generally taken for the subject about one half and thereby give that time to a more useful purpose. However, the time used for engineering drawing including the natural, practical, or drafting room method of descriptive geometry is well spent; but to require three or four hours per week for a term on the theory and older method is a great waste of time and consequently a regrettable injustice to the student. While the term engineering drawing has justly included the work of descriptive geometry in the catalog of many engineering schools, yet the descriptive geometry does not do justice to engineering drawing unless properly changed.

In attempting to show that the time generally given to descriptive geometry can be reduced about one half and at the same time better results obtained, the writer in this paper will hold to a fundamental analysis of the subject. Descriptive

geometry at present presents a strange circumstance since the subject can be developed by two general methods independent of each other and characteristically quite different. This fact has caused much argument since the descriptive geometry was first developed by that method which is least suitable—in fact ridiculously cumbersome—for the drafting of today. A person schooled in one method will see the subject complete and may have convictions which are a hindrance when judgment is made on the other method. The purpose here is to present the chief characteristics of these two general methods. With this knowledge anyone observing the purpose of the subject could appreciate the advantage of one method over the other.

Descriptive geometry even yet as given in recent texts is essentially after the first descriptive geometries and consequently is still highly mathematical, giving many of the unnecessary geometrical operations peculiar to its original invention as handed down by Mongé. The subject has not been brought to earth and has not been reduced to the field of drawing so that the student can see its fundamental intent and appreciate the natural relation he already has to the subject. Some texts claim a new method, but their claim rests on the mere fact that they have eliminated the trace of planes and the x, y, and z reference planes. Such eliminations do not make a new method. The solutions of the problems are essentially the same as in the original descriptive geometries.

For those who are not directly familiar with descriptive geometry, a definition of the subject and its origin may be helpful. Descriptive geometry, as the writer would broadly define it, is the description of objects by two or more views (mechanical drawings) placed in such a position as to give a condition of exact geometrical relationships, and also the obtaining of other information from those views. Descriptive geometry was invented by Mongé, a French mathematician and army engineer; and according to the thought of his time —last of the eighteenth century—the development of the subject was purely mathematical. The fact that it sprang full

grown from the mind of a single individual at that time and has not been greatly modified in its general development since, shows that the subject is still purely mathematical in its nature. Much effort, however, is being put forth by more recent authors to connect descriptive geometry with drafting so as to be practically useful.

The writer has mentioned two general methods by which the subject matter of descriptive geometry can be developed. These methods are: first, that method which, for the solution of problems, requires geometrical constructions and sometimes the turning or revolving of the object in question; and the second method is that in which the draftsman changes his position with respect to the object and draws another view which will give the required results. The first general method may be called one of auxiliary geometrical constructions and the revolving of the object, and the second may be called the *change of position* method. The first method mentioned is the one at present mainly used in texts, and there has been no differentiation as to its fundamentals from the other method. The second is the natural, practical, or drafting room method.

In order to appreciate the fundamental difference between the two methods and the resulting difficulties of the first method, it is important to recall some of the elementary points of drawing. In the first place drawing of any kind is a form of expression. Therefore, everyone has some natural tendency for it, and consequently performs the fundamentals quite unconsciously. That is, the artist in sketching an object is unconscious that the lines of sight which he is using diverge from his eye to each point of the object. He is also unconscious of the geometrical relationship that exists between any two or more of his sketches of the same object. In making the second view of an object he unconsciously puts the view on an unused portion of the sheet, or probably on a new sheet. It is a natural and universal convention that views are separated and not superimposed one over the other. He has but two methods of obtaining different views of the

object, first by turning the object if it be small enough, second by changing his position; but mark it down that he never draws one view on top of the other in either case. Note that it is just as easy, if not easier, to change his position as it is to turn the object.

Mechanical drawing or drafting is also a form of expression. Absolutely the only fundamental difference between drafting and the usual freehand drawing is that the draftsman uses parallel lines of sight instead of divergent. The draftsman as the artist quite naturally does the work but observes that one difference. Many draftsmen, like the artists, are unconscious of the geometrical relationships that exist in their work; but the good draftsmen being conscious of those relationships use them to advantage. But keep in mind that the draftsmen who are entirely unconscious of this geometrical relationship as well as the others never place one view on top of another.

The draftsman can also change his position or turn the object, but because of useful conventions in drawing, the work in mechanical drawing (descriptive geometry) is not equally easy for the two general methods of obtaining different views and solving problems. The conventions of engineering drawing force a rigid geometrical relationship between different views because these relationships can be used to advantage in the determination of unknown factors. The solution for unknowns in drawing is in the problem field of descriptive geometry. This geometrical relationship is such that in the first method of turning the object there results unavoidably one view on top of one of the other views along with a succession of logical geometrical constructions. Such a confusion and additional geometrical work is nonsensical since it is unnecessary. This is completely avoided by the change of position method and furthermore there are no accumulative geometrical constructions. The only constructions required are absolutely elementary.

Before showing the characteristic differences resulting from

the development of descriptive geometry after the two methods, it is best to have the fundamentals involved clearly stated. They are: (1) Propositions of plane and solid geom-

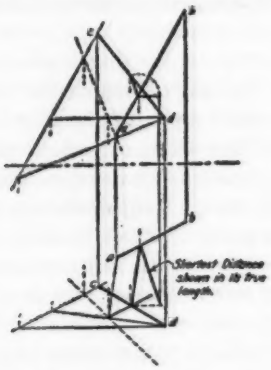


PLATE 1. PROBLEM OF FINDING THE SHORTEST DISTANCE BETWEEN LINES *ab* AND *cd* BY THE METHOD OF AUXILIARY GEOMETRICAL CONSTRUCTIONS AND REVOLUTION OF THE OBJECT.

etry. (2) Conventions and definitions of descriptive geometry. (3) Propositions of descriptive geometry.

In the development of descriptive geometry by the first general method, the relations of the problems to the fundamentals involved are best shown by Fig. 1. Within the circle are the

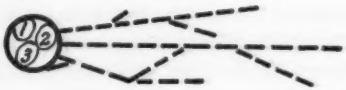


FIG. 1.

fundamentals while the dashes extending from the fundamentals represent the problems of descriptive geometry. It is seen that many problems depend upon previous problems. Hence it is evident that the additional knowledge of previous problems is required when the method of turning the object

and geometrical construction is used. This is not so in the second method. Just think of the time required in developing such a system of descriptive geometry. This system being built upon purely logical steps is, beyond the fundamentals, a phase of pure mathematics and quite apart from drawing as a means of useful expression.

In the development by the change of position method, the relation of the problems to these three sets of fundamentals can best be shown by Fig. 2. Within the circle are the same

FIG. 2.

three groups of fundamentals, while the lines radiating from the fundamentals represent problems of descriptive geometry. It is seen that each problem springs directly from the source and is independent of the solution of other problems. This is in accordance with the principle that *the best method is that method which keeps closest to the fundamentals.* Such a simple development of the subject cannot but help reduce the time required at present and increase the student's ability in handling the work.

This marked difference between the two methods can better be appreciated by the solution of a sample problem as shown on plates 1 and 2. Plate 1 shows the determination of the shortest distance between two lines and requires the knowledge or the thinking out of about seven previous problems or about fourteen distinct operations. The execution of the operations are partly superimposed. Plate 2 shows the same problem as solved by the second method and requires but two operations each the same. Each operation can be performed without interference with any work on the drawing. The solution depends upon no previous problem.

If descriptive geometry is to be taught in engineering

schools for the value of its content in aiding the draftsman, it should be developed from the experience discovered in its use

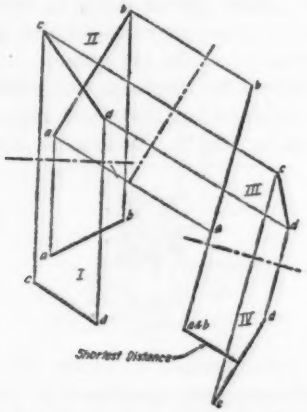


PLATE 2. PROBLEM OF FINDING THE SHORTEST DISTANCE BETWEEN THE LINES *ab* AND *cd* BY THE CHANGE OF POSITION METHOD. Views I and II given. III, new view simplifying the condition. IV, final view giving the result.

in the engineering drafting of today. Such a geometry developed from experience would have a more natural and direct usefulness. A glance at the present apparent extent of the use of descriptive geometry in practical work or drafting, will give some hint as to the naturalness of the change of position method. Upon inquiring of draftsmen—some chief draftsmen, some draftsmen of extended experience with some of the large engineering work of the country, and others of varying experience in drafting,—the following is about an average answer to the question "In what per cent. of your work do you use descriptive geometry?"—that in about 95 per cent. of all the drafting or drawing work done no conscious use is made of descriptive geometry. An effort was made to ascertain what these men called descriptive geom-

etry. Approximately they tended to call the descriptive geometry of their work those problems which were solved by a very few conscious geometrical operations, or those which were similar in solution to problems in some descriptive geometry text they had studied. However, as the writer has defined descriptive geometry, these draftsmen used a great deal of it, in fact, used it on every drawing and in some cases solved many problems which to them if solved by geometrical constructions would have been using descriptive geometry but they rather naturally put down what they wanted and this was obtained by changing their position with respect to the object. One point to keep in mind is that these draftsmen were doing their work, in putting down views of objects, with the same intuitiveness of expression as the freehand artist. If some of the draftsmen had not used the other method all the work would have been done without the use of descriptive geometry, according to their notion of the subject. Thus it is seen that the draftsman already has a conventional relationship to the change of position method.

As has been already stated the efforts of the more recent authors of descriptive geometries have been to connect the subject with drafting. But it is plainly evident that their texts have come out of the old geometries. They are making some steps in the right direction, but they are coming from the wrong place (classical descriptive geometries) and with a lot of mud hanging to their shoes. To come from the right place they would have to develop the subject from experience, —a re-discovery made in the drafting room. They would find the basic method the *change of position* method which connects naturally with drawing as a form of expression.

DISCUSSION: "ELECTRICAL ENGINEERING LABORATORY INSTRUCTION."

BY AUGUST HUND,

San Francisco, Cal.

I am taking the liberty to add a few comments on the subject of "Electrical Engineering Laboratory Instruction" as discussed by Professor Melville S. Munro in the November BULLETIN of this society.

Self reliance and independent thinking of a student can best be trained and developed in the laboratory, if a method of procedure is used in which the student is compelled to select and assemble his own apparatus for the particular experiment in hand. Naturally this requires a somewhat large and complete laboratory equipment, since every student will invariably tend to appropriate the simplest and most convenient apparatus for his work; however, excellent results can usually be realized if the laboratory work is properly assigned, and especially so, if the students work in groups. Many objectionable features can be eliminated by using special terminals on the connection blocks and cables whereby only certain instruments, leads or other apparatus can be put to a particular use. The introduction of such an interlocking arrangement will automatically provide against undue appropriation of the choicest apparatus by any one group of individuals, and with very little added expense, universal or master transfer devices may be provided for using such apparatus on other work as occasion may demand.

The above very briefly outlines the system as introduced some years ago at the Institute of Technology in Karlsruhe, Germany, by the late Professor E. Arnold. This well-organized and splendidly equipped laboratory attracts students and professional engineers from all over the world, and can well

serve as an example of such a system as has been described by Professor Munro.

A few specific remarks on the above laboratory will perhaps better illustrate some of the practical features of the actual operation of such a scheme: All the laboratory work is done in five-hour periods, between the hours of 2 and 7 P.M. The laboratory work is divided into the following classes:

1. Low Current Laboratory, for measurements of resistance, self-induction, capacity, insulation resistance and the like.
2. Heavy Current Laboratory, power apparatus.
3. High Potential Laboratory.
4. High Frequency Laboratory, for advanced students.
5. Special Laboratory, there are a few rooms which are especially set apart for post graduate work, and are very often equipped with special instruments and apparatus. It might be interesting to add that extra fees are usually charged for this sort of graduate work, but that much of the expense is covered by special endowments.

The men work in groups in all undergraduate work, and it has been found that two or three are the best number of men per group. The students finish most of the work in the low current laboratory before taking up the other phases of the work. The circuits of the low current laboratory are so arranged that the source of the current supply for each group is usually furnished from a separate storage battery, thereby lessening the disturbance and incident confusion which is usually caused by beginning students. The apparatus of this laboratory are simple and the experiments are planned so as to bring out the fundamental conceptions of electricity. The work is so managed that the students have to work out the problems by mutual consultation among the members of the group, after oral directions from the instructor in charge and printed information of the character of the test are given to

the group. The wiring of the beginning students is always checked by the instructor, at which time some additional information may be given as to the actual carrying out of the test, but after the men have developed some little skill, both the inspection and additional consultation are omitted. After the men have taken all the data for the test they are individually quizzed by the instructor. This makes it certain that each man thoroughly understands the work in hand. The high potential and high frequency tests are the only ones in which the instructor ever exercises any direct supervision. As the students become more advanced the scope of the experiments are enlarged to such a degree that very frequently an experiment or series of tests extends over a number of weeks.

The writer has assumed that the above might be appreciated since it is a report on the actual application of such a scheme as has been suggested for introduction in this country.